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The Impact of Software Development Team Dynamics on the Knowledge Management Process

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***Abstract*—The influence of software team dynamics on well-organized software development knowledge process could prevent software development organizations from suffering from the knowledge atrophy problem. To explore this, we have studied several team dynamics factors that influence the Knowledge Management Processes (KMP) in Very Small Entities (VSEs) [1]. A survey was conducted in a variety of VSEs and through statistical and qualitative content analysis for the research data, results indicate that small teams, informal team process and structure have an important influence on the level of team dynamics in the software development process**

Keywords-component; software process, knowledge

I. INTRODUCTION *(HEADING 1)*

Software development is a complex activity and depends strongly on human commitment for its implementation. Furthermore since software development projects involve knowledge intensive exchanges and collaborations, the influence of team dynamics on the organization of software development knowledge could assist software companies to become more innovative and efficient. Hence KMP is more effective in an organization if the development teams have a good team culture with ability to share knowledge, collaborative relationship and personal responsible in creating and sharing knowledge [2]. In addition KMP is also reshaped by the attitudes and behaviour of team in order to ensure that both personal and organizational knowledge are always available [3]. The issues of limited resources; especially in cost and people almost always become an issue and can have an impact on the KMP in VSEs [4]. Therefore it is our belief that better understanding the influence of team dynamics in software projects could assist small companies to mitigate VSEs KMP against the knowledge atrophy problem.

II. BACKGROUND

A. *Very Small Entities (VSEs)*

The definition of "*Small*" and "*Very Small*" companies is challengingly ambiguous, as there is no commonly accepted definition of the terms. In Europe, for instance, 85% of the Information Technology (IT) sector's companies have 1-10 employees. In the context of indigenous Irish software firms 1.9% (10 companies), out of a total of 630 employed more than 100 people whilst 61% of the total employed 10 or fewer, with the average size of indigenous Irish software firms being about 16 employees [5]. The term "*Very Small Entity*" (VSE) had been defined by the ISO/IEC JTC1/SC7 Working Group 24 "*an entity (enterprise, organization, department or project) having up to 25 people*" [6]. Furthermore the issues of limited resources in VSEs always become a constraint in producing a competitive product in today's dynamic software business. [7] states that micro enterprise including VSEs whose have limited resources, particularly in financial and human resources, are practicing unique processes in managing their business. These unique characteristics have influenced VSEs in their business style and companies' process infrastructures compare to large companies' [7]. In addition due to the small number of peoples involved company's activities, most of the management processes are performed through an informal way and less documented.

B. *Teams and Knowledge Management*

According to [8] software development is a combination of two basic processes; social process and technological process. [9] argues that software production is more effected by social process rather than technological process. People are not only claimed as the greatest asset in a software organization [10] but also critical to software development success [11]. Software is always developed in a group rather on the individual basis [8] and the basis of every software project is a team [11]. [12] argue that the dynamic performance software project which involved many processes is always depends on team especially in quality of communication within team and between teams. They added that the communication can be applied in many ways not only in verbal but also in term of documentation form such as version control, guidelines, reports and many more. Moreover the communication also has a related impact with the team proximity [7]. They add that the increase distance from one team to another could effected the team dynamics in which it will interrupt team communication, coordination, mutual support, effort and cohesion [13]. Therefore in order to be success in KMP, organization must have a solid support from the software development and management team. The development and management team must be able to work together, share the knowledge and able to communication one another effectively. This is because the essence of software development is good relationship, effective communication and

high esteem of teamwork among software development and management team.

C. Teams dynamics

Team dynamics effect how team reacts, behaves or performs and the effects of team dynamics are often very complex [15]. There are various forces could influence team dynamics including nature of the task, the organizational context and team composition. In her dissertation [14] on dynamics of successful software team identified four characteristics of team dynamics; positive, negative, internal and external team dynamics. Positive team dynamics is the positive forces that can lead a team be a high performing successful team. [16] states the present of social relationship in a team could increase team productivity and could enhance social and interpersonal skill [17]. [18] argues that social interaction skill dimension can divide a team member to extrovert or introvert. Extroverts' team member is a people oriented, sociable person, who enjoys interaction with others. Meanwhile introvert person is a type of person who like to work alone and with less social interaction. Meanwhile, [19] believes that the positive mode of leadership (such as well focus directive, well plan and others) in software organization could enhance the positive team dynamics. Negative team dynamics is a negative force that could lead the decrease of team performance and preventing people from contributes with their full potential [14]. According to [10], from management point of view, in software development organization people are required three types of needs that have to be fulfilled and satisfied; social, self-esteem and self-realization needs. Social needs are related to social interaction and communication. The lack or ignorance of these needs will give a negative impact on the organization because people may feel unsecured, have low job satisfaction and decrease their motivation [20]. These will stop them from giving full commitment and cooperate in their work as a team member. Internal team dynamics are referring to the forces that exist within the team itself [14]. Team member also will not cooperate if they do not feel that that are a part of the team [21]. While internal social interaction between people could build team cohesion that will enhance team performance. [29]. External team dynamics are referring to the present of external forces that beyond the team control and could impact the team performance [14]. According to [23] the intrinsic and extrinsic factors in projects may motivate team. Intrinsic factors are the internal factors that consist in the task and team activity itself. Extrinsic factors are external factors that influence team from the outside such as reward and recognition, feedback from the organization and customer, team member pressure and the working environments. Moreover a better working environment also could enhance job satisfaction among team member [24].

III. Study Methodology

For this study we have developed and distributed a survey questionnaire to software VSEs (involved in software product development) in Dublin, Ireland. The survey questionnaires (which followed a GQM approach) were consisted of quantitative and qualitative questions. In order to get a quick replied, we regularly contacted the respondents via email and phone. Each received and completed questionnaire were compiled and analysis. The close-ended questionnaire were grouped according the issue and analyze using a statistical analysis. Meanwhile, on the open ended data, we analyze and categories the data according to the category that this study intends to understand. In summary we adopted the qualitative contents analysis approach in analyzing the open-ended answer [23]. At the end, we have merged the both analysis result in order to gain more understanding and validate the results. We have received a total of 70 filled questionnaires and have conducted 15 interviews for this study, In order to produce details analysis results, we have divided the survey respondents into 2 main group namely the Micro VSE (M) (1-9 employees) and Larger VSE (L) (10-25 employees) [1].

IV. Findings and Discussion

A. Teams dynamics and Structure

In this section, we explore the respondents' opinions on the companies' software development team status and study people working relationship and team environment in the companies.

TABLE I. Team Dynamics

Grp		Clear Roles	Appropriate Size	Diverse Skill Range
M	Mean	3.60	3.20	3.60
L	Mean	3.60	3.40	4.00
Avg	Mean	3.60	3.30	3.80

Table 1 indicates that the respondents' strongly agree that the development teams in their companies have a high level of team dynamics. The results shows that the team have a great working and social relationships, willing to share opinion and idea, having a good interpersonal skill and working closely each other. Further, other results (data not shown here due to lack of space) show that even though VSEs having a small team and a flat structure but staff are clear about their roles, they have enough manpower and skill to do all the development tasks. Meanwhile from the qualitative analysis, indicated that all respondents claimed that their development teams are efficient and effective. They claimed that their development team are having all important criteria such as high skills, motivated, dynamic, socialize and good teamwork, open communication, able to meet project deadline and budget, active in sharing and involved in strategic planning. These points are illustrated in the following extracts from interviews: "*They get on well as a social group and communicate regularly and openly. Also the projects we manage are normally 1 to 2 man projects and hence easily manage in an ad-hoc manner by two people that get on and communicate well." 2) "We practice clear communication and we are active in informal knowledge sharing. Beside that our environment is a family culture and, following specific strategic planning... We also actively use communication tools.*"

Beside that the result on employee turnover rate question has strengthen the above finding regarding team environment in the VSEs. The result in this question shows that the companies do not have any serious problem with the staff turnover. They claimed that the company environment, management and working styles and team relationships that

satisfied the employees have motivated people to stay longer in company. The following interview quotations which best explain the details of this situation: *"We handle many varying projects of different sizes and complexities and have a very loose/informal and friendly atmosphere. This means the work is challenging and rarely gets boring while it also being enjoyable here." "We have 14 employees. Last one who resigned in was 3 years ago. The reason people stay is we operate in relaxed and informal environment."*.

In overall team environment issue give an indicator that all the above parts or processes are much related and depended to the organization team environment, process and culture in the organization

B. Communication

The results from the analysis as shown in table 2 indicate that the companies are practicing regular informal meetings (e.g stand-up meeting, online meeting) and practicing informal formal communication in their business operations. However the results also show that organizations have clear communication process and channel. Moreover the results also indicated that that employee size has influence the formal communication process level in their VSEs daily business operations. This has been shown in comparison results between the L-VSEs and M –VSEs for this issue.

TABLE II. COMMUNICATION PROCESS

Grp	Staff Knowledge	Project Exp. & Lesson Learned	Experience Doc	Progress & Procedure
M	2.20	2.20	2.20	2.20
L	2.80	3.20	2.80	2.60
Avg	2.50	2.70	2.50	2.40

In relation to the communication process in VSEs, the analysis on the open-ended question indicated that 90% of respondents are agreed that in development projects they regularly receive feedback from the project stakeholders. However the result showed that this process been done either in face to face, informal discussion, online communication, informal internal feedback or 'on the job training' process. The interview extracts following illustrates how the process has happened: *"Online communication, informal feedback, internal discussion, and informal communication" "We sit in one office so I talk to them all the time"*

C. Learning and Sharing

All respondents' are agreed that their development team sharing and learning activities are active in the organization. This was shown from the research result which obtained more than 3.00 point in mean. This represents an indicator that in VSEs companies, they always utilize the knowledge and experience within the organization in performing their tasks. This analysis also found out that there are no big differences in term of company size in utilizing existing knowledge and experience in company.

Related to above data the open-ended question indicated that the learning and sharing activities in VSEs are being done either informal self-learning or informal knowledge sharing among the development team. This has shown how the employees enhance their skills which resulted in 90% of the respondents agreed that no formal training were given to the staff in enhancing their skills. The interview extracts below reflect the above points: *"Informally through ad-hoc conversations and some code review", "Ensuring that no single member of staff has any exclusive knowledge by using a mentoring/buddy system."*

D. Documentation Process

Our data indicates that the documentation process has been done in informal process. In details it showed that people's knowledge, experience and activities are not documented properly or have been done personally. This was showed on the total mean score which presents that all respondents do not practice a formal documentation process in their documentation activities. Our data also indicates that number of employees working in the companies give an influence to the documentation formality process in VSEs.

In relation, the qualitative answers have highlighted that only business procedure and technical issues are being documented properly and organized. This could be identified in question on documentation process where 50% of the respondents claimed they felt that they are regularly update their document regularly especially on a specific works and procedures. Moreover the analysis results also showed that small team size issue is an obstacle to VSEs from performs seriously documenting their activities as shown by below interview extracts: *"We documented it electronically, and having an equal decision on it". "We are too small to do proper documentation process"*

The result in this part of analysis demonstrates a pattern and indication that in VSEs documentations process are done in two ways; (1) the specific documentation process which is related to business and technical process and (2) informal documentation process which are inclined toward informal, personal and online documentation.

E. KM Process and Commitment

The questions on this part emphasize particularly on KM process and commitment in the software development projects. The results from the analysis as shown indicate that the respondents were agreed that the level of KM process and commitment in VSEs are very significant. This could be identified with the average mean score for each question is relatively high. Our data indicates that in principle respondents are agreed they are having a clear KM strategy and a good leadership in their organization is important in organization software development knowledge as reflected in the mean score results for these two questions. However our results indicate that activities related to KM within VSEs have not been performed properly. It is indicated in average total mean row that gained less than satisfied agreement level. Our data showed that the management is very supportive in the KMP and peoples in the organization are always communicate, share and having good relationship among them. This issue could be identified in open-ended answer related to which indicates KMP were done informally through sharing activities and informal documentation such as personal or impromptu process

as the interview extracts below show: *"We are doing more on self-learning and sharing among us", "Regular sharing process, internal sharing and team work"*.

In addition to the above analysis, the analysis of the knowledge loss issue have indicate that the informal process environment in VSEs helps the companies to mitigate knowledge loss problems from happened. The analysis in this part showed 90% of the respondents claimed that they do not face knowledge loss problem in their company due to the informal process. These interview extracts illustrate this situation: *"Ensuring that no single member of staff has any exclusive knowledge by using a mentoring/buddy system.", "Not a problem since we are using the same technology and process in all our project…. We occasionally sharing and transferring knowledge among each other"*.

V. CONCLUSION AND FUTURE WORK

The analysis has indicated that VSEs have a clear KMP in their organization. The results also show the knowledge atrophy problem is not a serious problem in VSEs. From the analysis we found that due to small team size which creates a flat work structure, direct and active communication, close relationship and open environment have created positive team dynamics environments in respondents' organization. These situations also have encouraged software development teams to share and create knowledge in organization. In addition the analysis in the first stage (qualitative) have indicated that management style in VSEs which is more informal and macro, and working style which more autonomous have helps to create team dynamics environments. This situation help VSEs enhance their KMP and mitigate several factors which lead to knowledge atrophy problems. This is shown from the analyses which have indicated that in VSEs knowledge sharing level is high; staff turnover rate is low, high levels of knowledge exploration, continuous guidance from the senior staff and active communication in exchanging idea or knowledge among staff. Meanwhile in second stage data analysis process indicates that 90% from our research respondents believed that informal process environment in their organization has helped the development team to become more dynamic and this situation has assisted them in KMP beside mitigated knowledge atrophy problem from happened. In addition, the second stage data analysis result also shows that 80% of respondents claimed that their software development activities are not affected by the knowledge atrophy problem. They claimed that by, having frequent guidance and mentoring activities, being active in knowledge sharing and proactive coaching could mitigate this problem from occurring.

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